

SOLUTION INTRODUCTION



Cambium Networks

22 March 2013

WHO IS CAMBIUM NETWORKS?



Industry leader in Point-to-Multipoint and Point-to-Point IP Wireless Broadband Solutions

**Independent company since 2011
(Formerly part of Motorola Solutions)**

More than 4 million nodes shipped totaling over \$1B to thousands of networks in over 150 countries

Uniquely positioned to deliver breakthrough Wireless Solutions to Service Providers globally

Financial healthy and profitable company with a strong equity investor, Vector Capital

CAMBIUM NETWORKS



Orthogon Point-to-Point (PTP) Access and Backhaul Links

- Market Leader in sub-6 GHz Cognitive Radio Technology
- Spectrally agile using Dynamic Spectrum Optimization™
- 3G & 4G/LTE backhaul
- Used for the most challenging links globally!



Canopy Point-to-Multipoint (PMP) Access Networks

- Market leader in unlicensed & licensed PMP
- Small cell backhaul
- Ideal for enterprise access
- Residential broadband access
- Voice, video and data capable

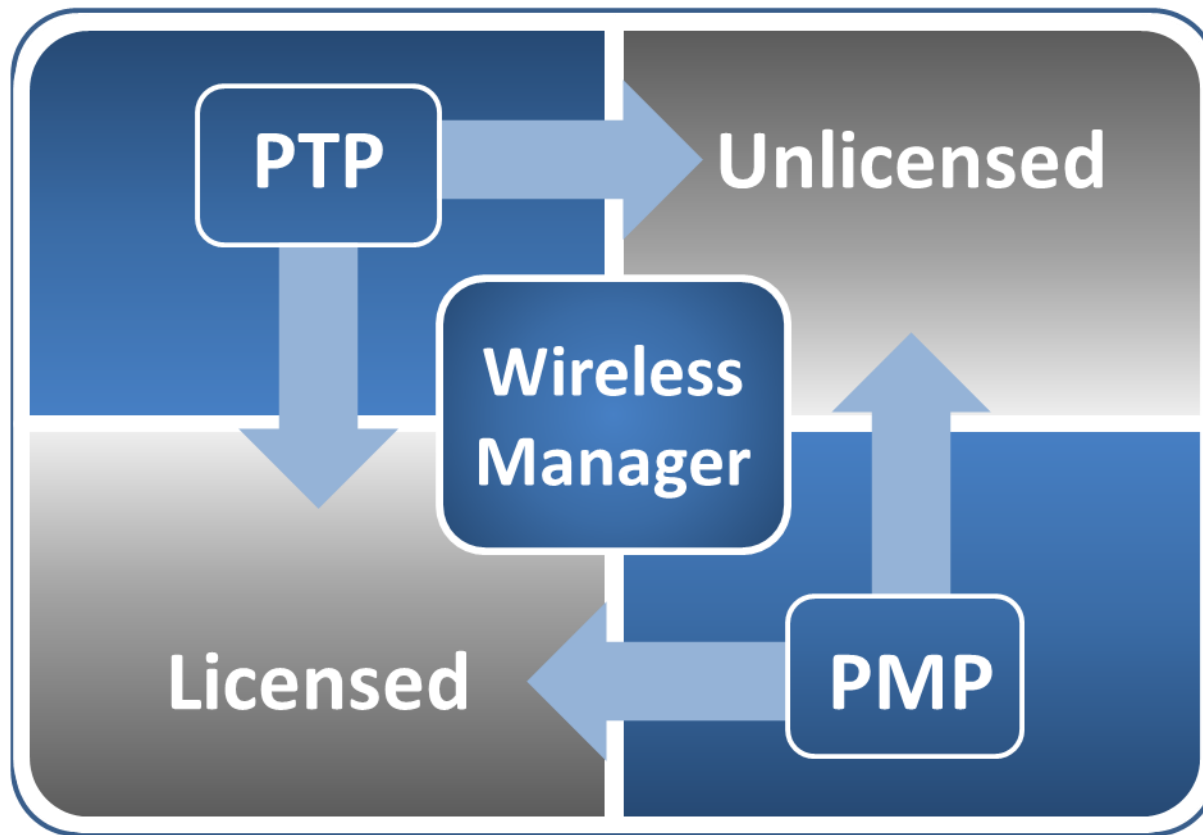
OUR STORY BY THE NUMBERS

Cambium Networks Footprint

240+	Experienced professional staff dedicated to PTP/PMP
3,500,000+	Radio modules deployed
150+	Countries deployed
4,000+	Networks deployed
14	International awards
2,000+	Global partners actively selling
287+	Program-certified technicians
250+	Published case studies
250,000	Topic views per month on the Web site

CAMBIUM COVERS IT ALL

Cambium Covers All



SERVICE PROVIDERS CHOOSE CAMBIUM

Applications

- Core backbone Networks and Spurs
- Small Cell Backhaul
- Cell Site on Wheels (COWS)
- Disaster Recovery/Business Continuity
- Cell Site Enterprise Broadband Access
- WiFi Backhaul
- Rapid/Temporary Deployment

Proven Performance

- Near/Non Line of Site Operation
- Highly Reliable
- Unparalleled unlicensed expertise
- Ease of Deployment
- Interference Tolerance
- Information Assurance / Secure



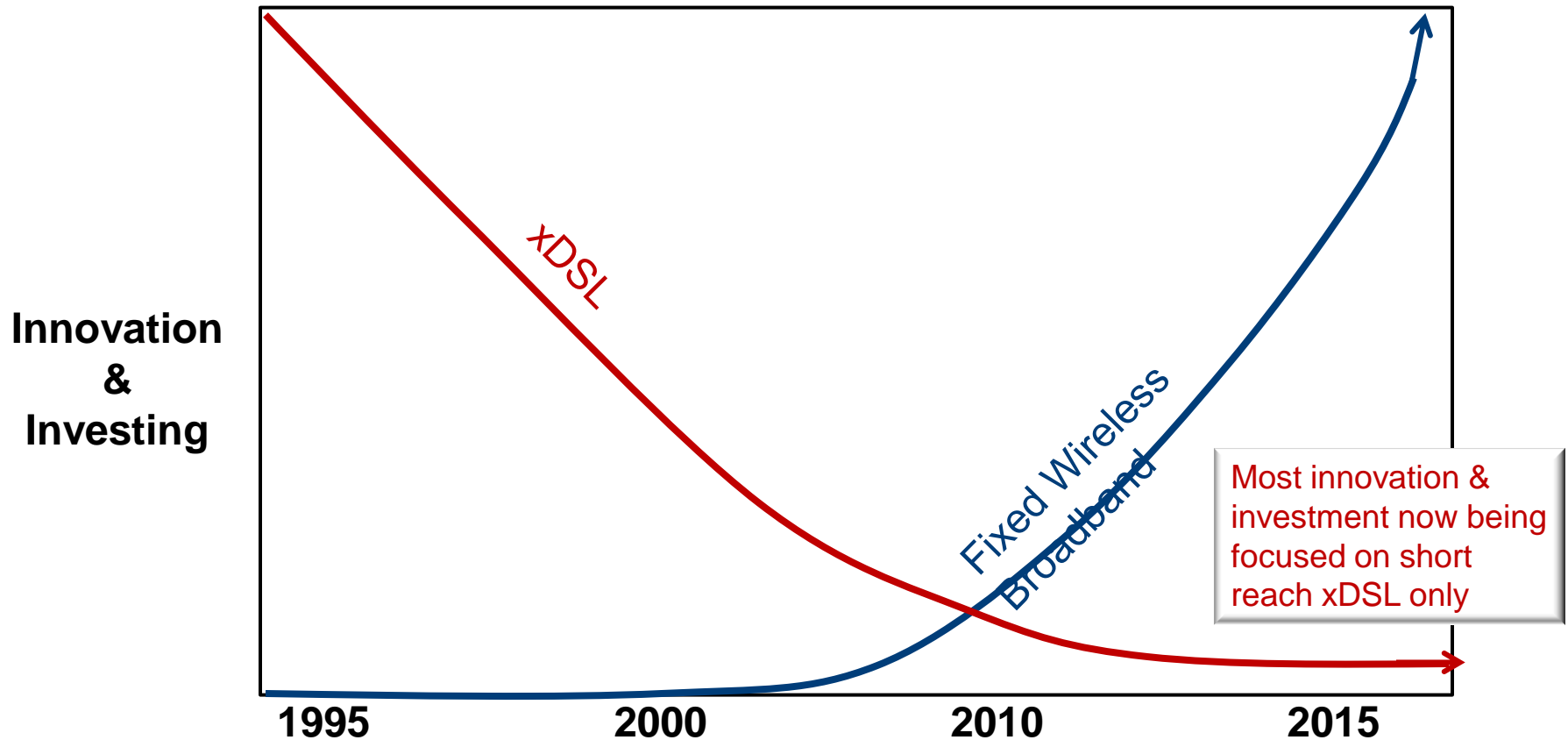
CHINA MOBILE



The Bigger, Better Network.



BROADBAND TECHNOLOGY EVOLUTION



Fixed wireless broadband is benefiting from 3G / LTE + WiFi

CAMBIUM MARKET OVERVIEW & EVOLUTION

Fixed wireless broadband has been deployed by WISPs for years with tremendous success and customer satisfaction

Vertical Markets and WISPs

- Government, Public Safety, Utilities, Oil & Gas, Enterprise, Military...
 - Continued focus and expansion in all Verticals
 - Much more collateral and support coming
- Established WISPs
 - Developed voice and video strategy to drive sales through ARPU growth
 - C3 to enable video
 - ATA/SIP gateway with router integration drives ARPU and reduces truck rolls
- Emerging WISPs are being focused on
 - New Platform to be released to address the emerging WISP market and low ARPU users
 - All new users will benefit from ARPU services focus



Wireline Service Providers

- Rural and “last mile” coverage
- Developed Countries – PMP 450
 - Enables Triple Play
- Developing Countries – New Platform
 - Addresses low ARPU users



Wireless Service Providers

- 3G and Wifi backhaul
- LTE Backhaul for Macro-cells
- Broadband Access for SMB
 - 450 on their towers!
- Small Cell Backhaul for LTE



THE CONNECTIVITY CHALLENGE

The definition of Broadband has rapidly evolved from browsing and file transfer to Video Services (not SD but HD)

More frequencies and nLOS capability is need to address congestion and improve coverage, backhaul capacity and performance

Must derive more ARPU from your existing customers (residential and enterprise) while upgrading to higher speed Broadband

CONNECTING THE
UNDERCONNECTED
& UNCONNECTED



THE GOALS OF THE CONNECT AMERICA FUND

Overall Goal

Universal Service Reform

1. Principles and Goals. We begin by adopting support for broadband-capable networks as an express universal service principle under section 254(b) of the Communications Act, and, for the first time, we set specific performance goals for the high-cost component of the Universal Service Fund (USF) that we are reforming today, to ensure these reforms are achieving their intended purposes. The goals are: (1) preserve and advance universal availability of voice service; (2) ensure universal availability of modern networks capable of providing voice and broadband service to homes, businesses, and community anchor institutions; (3) ensure universal availability of modern networks capable of providing advanced mobile voice and broadband service; (4) ensure that rates for broadband services and rates for voice services are reasonably comparable in all regions of the nation; and (5) minimize the universal service contribution burden on consumers and businesses.

The Cost and Speed Goal

Phase I. To spur immediate broadband buildout, we will provide additional funding for price cap carriers to extend robust, scalable broadband to hundreds of thousands of unserved Americans beginning in early 2012. To enable this deployment, all existing legacy high-cost support to price cap carriers will be frozen, and an additional \$300 million in CAF funding will be made available. Frozen support will be immediately subject to the goal of achieving universal availability of voice and broadband, and subject to obligations to build and operate broadband capable networks in areas unserved by an unsubsidized competitor over time. Any carrier electing to receive the additional support will be required to deploy broadband and offer service that satisfies our new public interest obligations to an **unserved location for every \$775 in incremental support**. Specifically, carriers that elect to receive this additional support must provide broadband with actual speeds of at least **4 Mbps downstream and 1 Mbps upstream,2 with latency suitable for real-time applications and services such as VoIP**, and with monthly usage capacity reasonably comparable to that of residential terrestrial fixed broadband offerings in urban areas. In addition, to ensure fairness for consumers across the country who pay into USF, we reduce existing support levels in any areas where a price cap company charges artificially low end-user voice rates. 7.

THE GOALS OF THE CONNECT AMERICA FUND

The Deployment Goal

Carriers accepting the state-level commitment will be obligated to meet rigorous broadband service requirements— with interim buildout requirements in three years and final requirements in five years—and will receive CAF funding, in an amount calculated by the model, over a five-year period, with significant financial consequences in the event of non- or under-performance. We anticipate that CAF obligations will keep pace as services in urban areas evolve, and we will ensure that CAF funded services remain reasonably comparable to urban broadband services over time. After the five-year period, the Commission will use competitive bidding to distribute any universal service support needed in those areas.

This Is NOT the Connectivity Solution!



- Too Expensive to meet the requirements of CAF
- Construction will take too long to bring broadband to rural America in a timely manner

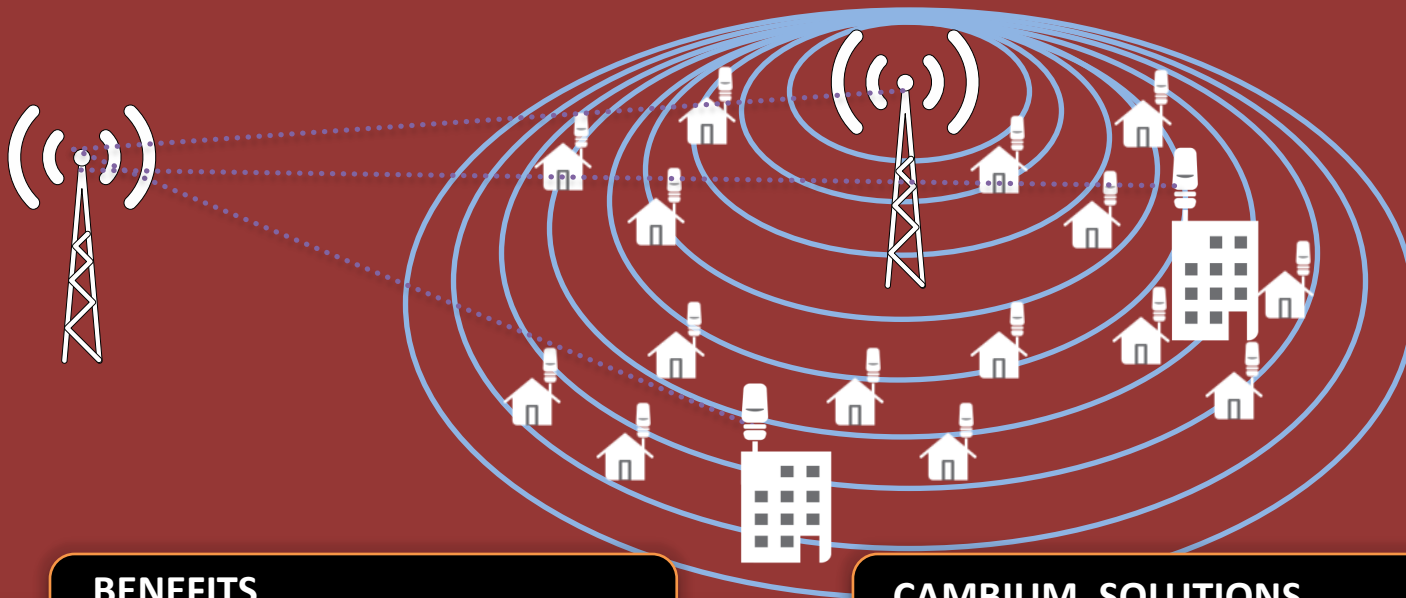


Cambium Networks

POINT TO MULTIPOINT (PMP) PRODUCT OVERVIEW

Introducing the New f TTP_{TM}

FREQUENCY to the Premise with 4G Fixed Wireless Broadband!



BENEFITS

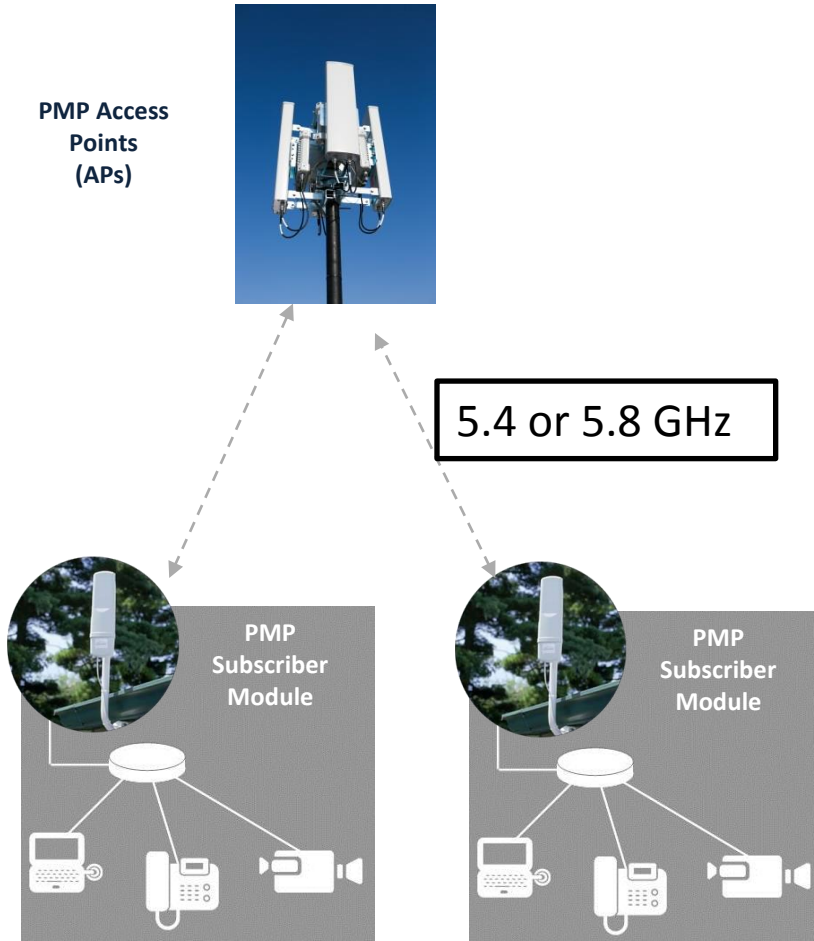
- Consistent coverage across large service areas and long distances
- Supports voice, video, and data
- No trenching, boring, or physical plant work
- Can be installed rapidly

CAMBIUM SOLUTIONS

- PMP and PTP product portfolios which meet all budgets and bandwidth needs
- Incredibly reliable field-proven technology
- Can support VoIP, VoD/NVoD, and IPTV
- Can be deployed NOW!

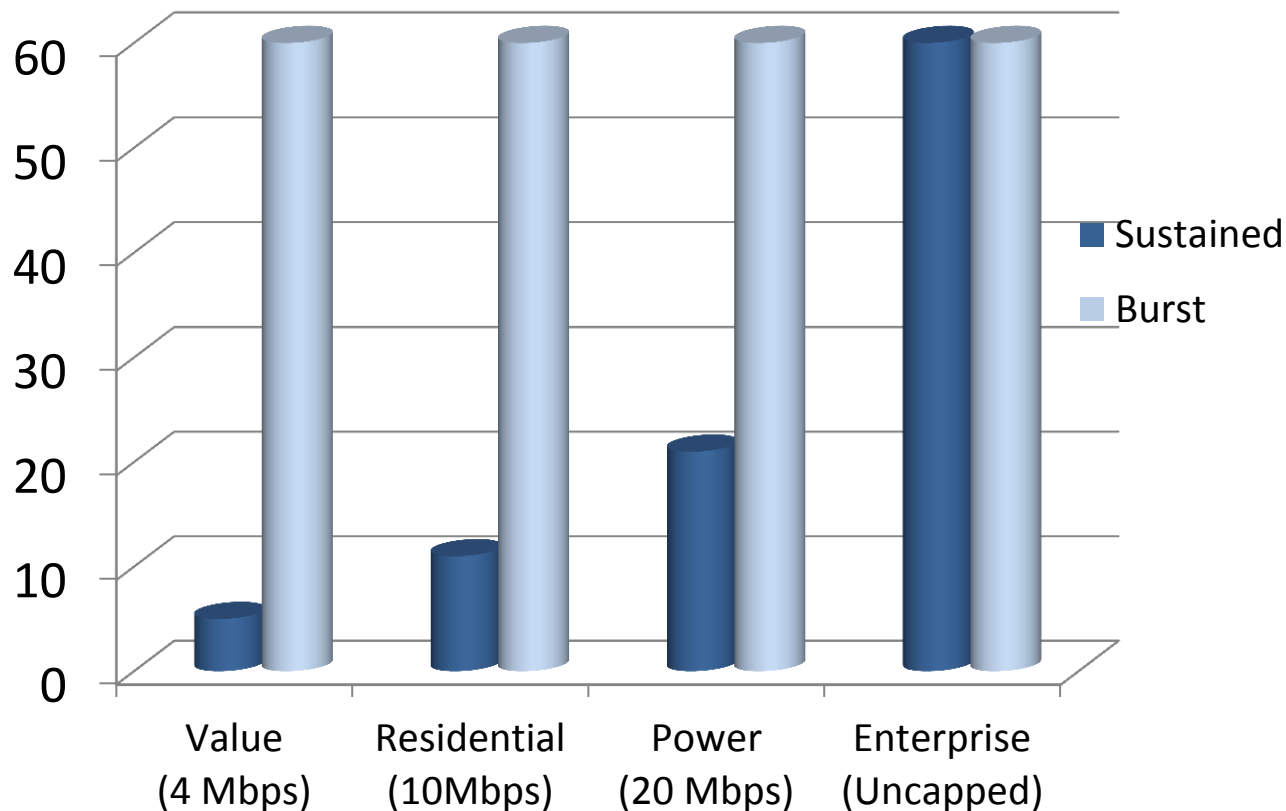
PMP – The Basics

Network requires an AP and Remote/Subscriber Modules



- **Fixed Wireless means fixed endpoints for a reliable and predictable service**
- **Access Points (AP) provide 90 Mb/s**
- **One AP can support up to 200 Remote Modules (RM)**
- **Each RM can support approximately 38 Mb/s symmetrical (best case)**

PMP 450 SUBSCRIBER MODULE TIERS



Fully Upgradeable from 4 to 60+ Mbps

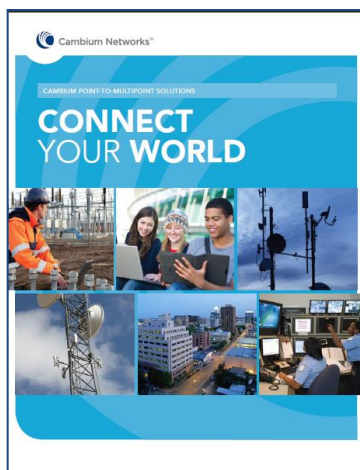
Burst bucket has been increased from 500 Mb to 2.5 Gb!

Keys Available to easily move between Tiers

CANOPY PMP PORTFOLIO

Proven Access Network Solutions

Product	PMP 105	PMP 120	PMP 130	PMP 320	PMP 400	PMP 430	PMP 450
Design Focus	Budget Small networks	Budget Large networks	Cost Effective Large networks	802.16e 3.5 / 3.65GHz Fixed Outdoor	Public Safety 4.9 GHz	High Performance Large Networks	High Performance Large Networks
Throughput	14 Mbps / sector	7 Mbps / sector	14 Mbps / sector	48 Mbps / sector	20 Mbps / sector	50 Mbps / sector	>90 Mbps / sector
Spectrum (GHz)	900 MHz, 2.4, 5.2, 5.4, 5.8,	900 MHz, 2.4, 5.1, 5.2, 5.4, 5.8, 5.9, 6.05	900 MHz, 2.4, 5.1, 5.2, 5.4, 5.8, 5.9, 6.05	3.3, 3.5, 3.6	4.9	5.4, 5.8	5.4, 5.8



- **Low-Cost, Low-Complexity, Low-Maintenance Infrastructure**
- **Scalable from small to region wide deployments**
- **Consistent throughput and low latency**
- **Rapid Deployment**
- **Supports Video, Data, Voice and Control Applications**
- **NLOS, nLOS and LOS performance**
- **Industry standard or proprietary options**

PMP SOLUTION

Access Points (AP)

Unlicensed APs



Licensed APs

Wireless Manager



Remote Modules (RM)



Accessories



Reflector



Lens



Cluster Mgmt
Modules (CMM)



Surge
Suppressors



Mounting
Brackets



PoE
Power
Supplies

PMP 450: ACCESS POINT DIMENSIONS



PMP 450

- 4th Generation (4G) of PMP product family from Cambium
- Dramatically increases overall **system capacity**
 - **Up to 1Gbps of tower bandwidth available.**
 - **Can support any symmetrical or asymmetrical speed**
- OFDM MIMO provides near Line of Sight (nLOS) and LOS access
- **Software defined radio design** allows for rapid coverage of new/existing frequency bands both licensed and unlicensed
- Utilizes **GPS synching capability** to achieve maximum spectral efficiency and very low latency **supporting VoIP and video**
- Installation and turn up in days, not weeks and months



CAF Applicability

- **Primary reference is Further Notice of Proposed Rulemaking**
 - **Adopted October 27, 2011**
 - **Released November 18, 2011**
- **Qualification for applicable technology is based on the plan's requirements**
 - Specifically, carriers that elect to receive this additional support must provide broadband with actual speeds of at least 4 Mbps downstream and 1 Mbps upstream, with latency suitable for real-time applications and services such as VoIP, and with monthly usage capacity reasonably comparable to that of residential terrestrial fixed broadband offerings in urban areas. In addition, to ensure fairness for consumers across the country who pay into USF, we reduce existing support levels in any areas where a price cap company charges artificially low end-user voice rates.

CAF Applicability

- There are three types of “wireless” technologies
 - Satellite
 - Mobility
 - Fixed Wireless.

CAF Applicability

CAF Requirements

- **Paragraph 86**

- As a condition of receiving federal high-cost universal service support, all ETCs, whether designated by a state commission or the Commission,¹²⁶ will be required to offer broadband service in their supported area that meets certain basic performance requirements and to report regularly on associated performance measures. ETCs must make this broadband service available at rates that are reasonably comparable to offerings of comparable broadband services in urban areas.

- **Paragraph 88**

- To help ensure reasonable comparability of the capabilities offered to end users, we provide guidance in this section on benchmarks for evaluating whether particular broadband offerings adequately afford these capabilities, in order to provide clear performance targets and ensure accountability. Specifically, we discuss the technical characteristics of broadband offerings – **speed, latency, and capacity** – that influence the capabilities afforded to users, and therefore their ability to use broadband connections for the key purposes articulated above. We also discuss characteristics common to the broadband buildout obligations imposed on all recipients of the CAF.

CAF Applicability

CAF Requirements Outlined

- **Paragraph 90**

- Broadband services in the market today vary along several important dimensions. As discussed more fully below, we focus on **speed, latency, and capacity** as three core characteristics that affect what consumers can do with their broadband service, and we therefore include requirements related to these three characteristics in defining ETCs' broadband service obligations.

Component of CAF	Broadband Performance Characteristics
Price Cap CAF (Phase I) (Incremental support)	<ul style="list-style-type: none">- Speed of at least 4 Mbps/1 Mbps to a specified number of locations, depending on level of incremental support- Latency sufficient for real-time applications, including VoIP (100 milliseconds)- Usage at levels comparable to terrestrial residential fixed broadband service in urban

CAF Applicability

Rejected Technologies

- **Paragraph 104**

- As a condition of receiving federal high-cost universal service support, all ETCs, whether designated by a state commission or the Commission,¹²⁶ will be required to offer. We limit this definition to fixed, terrestrial providers because we think these limitations will disqualify few, if any, broadband providers that meet CAF speed, capacity, or latency minimums for all locations within relevant areas of comparison, while significantly easing administration of the definition. **For example, the record suggests that satellite providers are generally unable to provide affordable voice and broadband service that meets our minimum capacity requirements without the aid of a subsidy: Consumer satellite services have limited capacity allowances today, and future satellite services appear unlikely to offer capacity reasonably comparable to urban offerings in the absence of universal service support.¹⁷⁰ Likewise, while 4G mobile broadband services may meet our speed requirements in many locations, meeting minimum speed and capacity guarantees is likely to prove challenging over larger areas, particularly indoors.¹⁷¹ And because the performance offered by mobile services varies by location, it would be very difficult and costly for a CAF recipient or the Commission to evaluate whether such a service met our performance requirements at all homes and businesses within a study area, census block, or other required area. A wireless provider that currently offers mobile service can become an “unsubsidized competitor,” however, by offering a fixed wireless service that guarantees speed, capacity, and latency minimums will be met at all locations within the relevant area.** Taken together, these considerations persuade us that the advantages of limiting our definition of unsubsidized providers outweigh any potential concerns that we may unduly disqualify service providers that otherwise meet our performance requirements. As mobile and satellite services develop over time, we will revisit the definition of “unsubsidized competitor” as warranted. Recognizing the benefits of certainty, however, we do not anticipate changing the definition for the next few years.

CAF Applicability

Definition of fixed voice and broadband

- **Paragraph 104 – Footnote 169**

- We define a fixed voice and broadband service as one that serves end users primarily at fixed endpoints using stationary equipment, such as the modem that connects an end user's home router, computer, or other Internet access device to the network. This term encompasses fixed wireless broadband services (including services using unlicensed spectrum). The term does not include a broadband service that serves end users primarily using mobile stations. See 47 U.S.C. § 153(34) (“The term ‘mobile station’ means a radio-communication station capable of being moved and which ordinarily does move.”). develop over time, we will revisit the definition of “unsubsidized competitor” as warranted. Recognizing the benefits of certainty, however, we do not anticipate changing the definition for the next few years.

CAF Applicability

Fixed wireless meets all requirements

- **Paragraph 90**

- Broadband services in the market today vary along several important dimensions. As discussed more fully below, we focus on **speed, latency, and capacity** as three core characteristics that affect what consumers can do with their broadband service, and we therefore include requirements related to these three characteristics in defining ETCs' broadband service obligations.

Component of CAF	Broadband Performance Characteristics	Fixed Wireless Broadband
Price Cap CAF (Phase I) (Incremental support)	<ul style="list-style-type: none">- Speed of at least 4 Mbps/1 Mbps to a specified number of locations, depending on level of incremental support- Latency sufficient for real-time applications, including VoIP (100 milliseconds)- Usage at levels comparable to terrestrial residential fixed broadband service in urban	<ul style="list-style-type: none">* Can support up to 38 Mbps fully symmetrical* latency equals 5 milliseconds* Fully comply

Margaretville, NY Cambium PMP320

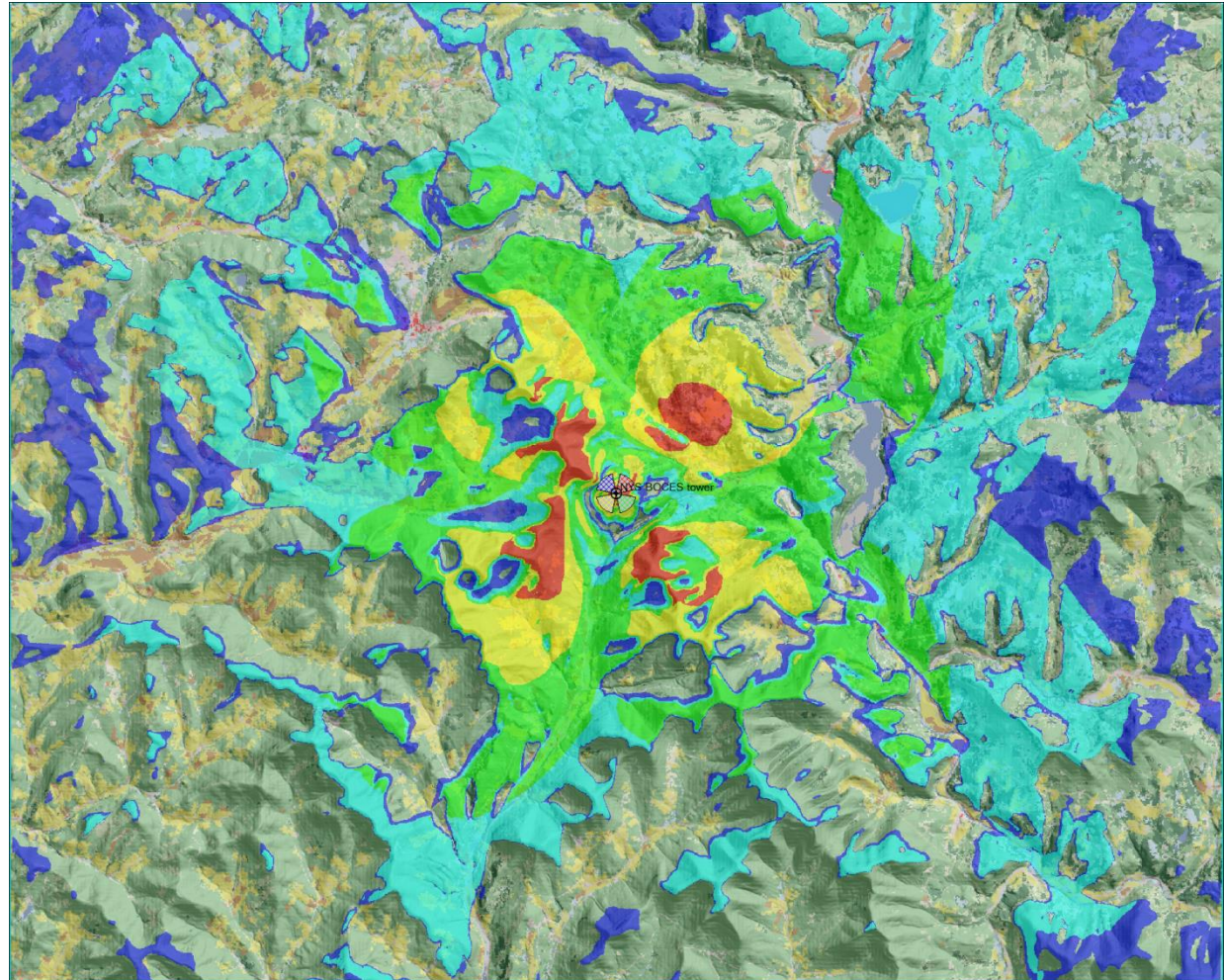
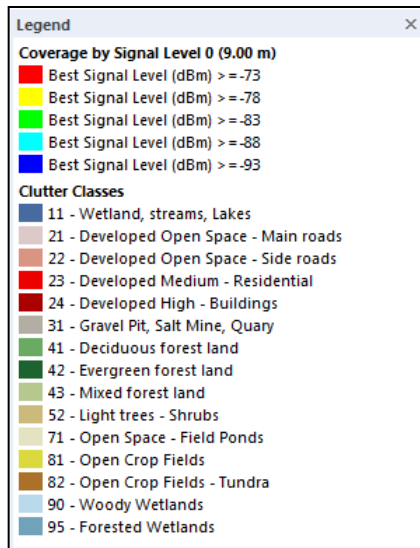
Coverage by Signal Level (Rendered via Atoll)

Site Info:

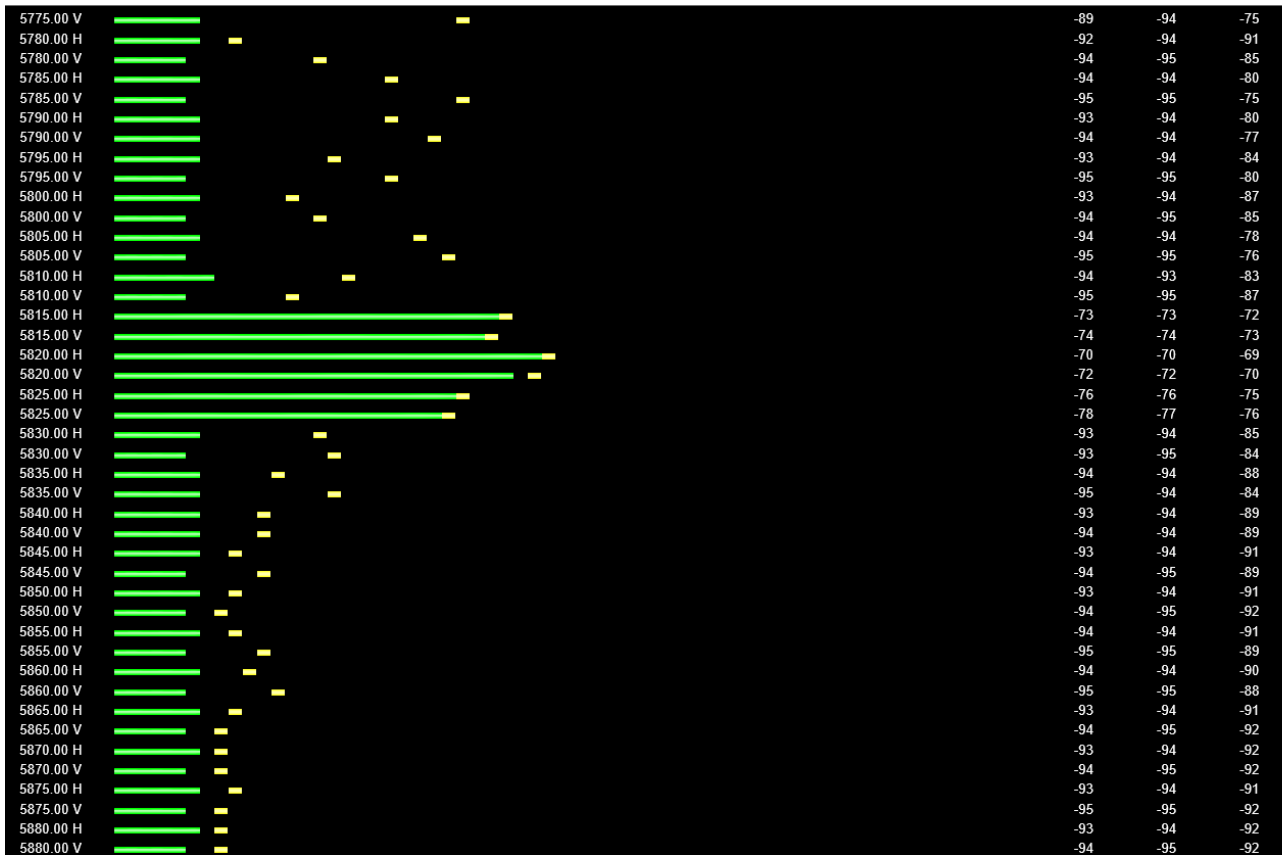
NYS BOCES Tower
Jump Brook Rd
Grand Gorge, NY
Latitude: 42.3584
Longitude: -74.5404
Tower Height: 180'

PMP320 @ 10Mhz Chan:

Sector1 AP @ 45°; 50' Height
Sector2 AP @ 135°; 170' Height
Sector3 AP @ 235°; 170' Height
Sector4 AP @ 335°; 170' Height



PMP 450 – Remote Module



Each AP and RM contain Spectrum Analyzer so the install tech can find the cleanest band



RMs offer LEDS or Audio port for turn up and connection

Why PMP 450 for Residential Broadband

- Ability to offer Data, Voice and Video including IPTV and HD
- Substantially less costly than FTTH with ability to provide similar services
- Much faster to deploy with no digging, trenching, boring...
- Only way to cost effectively deliver Broadband Services to low density and rural customers and for overbuilds
 - Complements FTTH
 - Best way to address low take rates
- Can roll voice traffic onto PMP 450 and eliminate copper maintenance costs
 - Also allows for the long term removal of the class 5 switch
- Future AP upgrades allow improved speeds



Why PMP 450 for Residential Broadband

- Meets all the technical requirements of CAF
- Meets the cost targets, allowing the FCC to maximize allocated dollars
- Quick turn allows for providing connectivity to the rural subscribers that CAF has targeted
- Fixed wireless will allow the FCC to boast of the success of the CAF program

Thank you



Cambium Networks